NASA TECH BRIEF

Langley Research Center

Braking Action of Wheeled Vehicles Is Controlled Automatically During Minimum-Distance Stops

An automatic system for controlling the braking action of wheeled vehicles prevents tire skid during panic stops. In this system, two mutually dependent accelerometers directly control a solenoid valve which regulates the braking pressure and automatically selects a pressure to produce a near-maximum braking effort and then maintains that pressure, essentially constant, throughout the remainder of the stop. In this manner, during minimum-distance stops, the maximum degree of wheel slip allowed by the system will be directly proportional to the degree of deceleration the vehicle is able to attain on a given road surface. The system not only eliminates the problem of skidding but also has the potential for automatically adjusting to changing braking conditions so as to maximize tire traction on any road surface.

The control system consists of a wheel sensor unit mounted on the rear axle of the vehicle and a brake pressure stabilization valve in the brake line leading to the rear wheels. The wheel sensor unit contains a rotational sensing mass, four rotational sensing-mass support springs, and a sensing-mass support plate which all rotate with the rear wheels. The sensor unit also contains a translational sensing mass, four translational sensing-mass support springs, and a sensing-mass support plate which are secured to the body of the vehicle. The rotating and nonrotating sensing masses are separated by ball bearings.

Wheel and vehicle decelerations, which occur when the brakes are applied, produce inertial loads which act on the translational sensing mass as well as the rotational sensing mass and cause the sensing masses to press against one another. When the magnitude of the rotational load exceeds the magnitude of the translational load, the rotational mass overpowers the translational mass and results in a clockwise rotation of the rotational sensing mass, relative to the wheels, and a corresponding straightening of the support springs. At the same time, the translational sensing mass is forced rearward, with a corresponding increase in the deflection of the support springs, to activate a reed switch which, in turn, energizes the pressure stabilization valve. The sequence of events, from the instant the sensor unit begins its response until the pressure in the brake line has actually been stabilized by the valve, occurs in a time span as short as 15 milliseconds.

When the brakes are applied, fluid flows from the master cylinder into the valve and forces the valve plunger off the valve seat; fluid then flows out to the wheel brake cylinders. When the brake lining contacts the brakedrums, pressure equalizes throughout the brake system and permits the valve plunger, by virtue of its weight, to settle back on the valve seat. With the valve plunger in this position and the reed switch in the sensor unit closed, the time required to stabilize brake pressure to the rear wheels is, essentially, the time required to energize the solenoid coil which presses the valve plunger firmly against the valve seat.

Any one of the following operating modes can be obtained, provided the weights of the two sensing masses are properly proportional relative to one another.

a. For maximum sensitivity, the rotational sensing mass is made sufficiently large, compared to the translational sensing mass, so that the unit will activate at virtually the instant the brake lining contacts the brakedrums.
b. For minimal sensitivity, the rotational sensing mass is made sufficiently small, compared to the translational mass, so that the unit will not activate even to the point of locking the wheels.
c. For optimum operating mode, located somewhere between the two extremes, the sensing masses are sized relative to one another so the system will

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permit the wheels to be decelerated to some rate just prior to wheel locking. At essentially the same instant that rate is attained, brake pressure will be stabilized by the system.

The response of the wheel sensor is based not upon a single deceleration but upon the ratio of two decelerations, the wheels and the vehicle. As long as braking is normal, a stabilization of vehicular deceleration will be accompanied by a corresponding stabilization of wheel slip. During abnormal braking, vehicular deceleration will again stabilize at some maximum value while wheel slip will continue to increase. It is at that instant that this control system stabilizes brake pressure to the wheels, thereby demonstrating its ability to maximize braking action on all operating surfaces.

Notes:

1. The following documentation may be obtained from:

   North Carolina Science & Technology
   Research Center
   Post Office Box 12235
   Research Triangle Park, North Carolina 27709
   Single document price $3.25
   Reference: NASA TM X-72665, A Unique Concept for Automatically Controlling the Braking Action of Wheeled Vehicles During Minimum Distance Stops

2. Technical questions may be directed to:

   Technology Utilization Officer
   Langley Research Center
   Mail Stop 139-A
   Hampton, Virginia 23665
   Reference: B75-10264

Patent status:

This is the invention of a NASA employee, and U.S. Patent No. 3,744,850 has been issued to him. Inquiries concerning license for its commercial development may be addressed to the inventor:

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